

**Table 2**  
**Catalyst poisons and inhibitors in chemical processes [Ullmann, 1985]**

Process	Catalyst	Catalyst Poison, Inhibitor	Mode of action
NH <sub>3</sub> synthesis	Fe	<p>S, Se, Te, P, As compounds, Halogens</p> <p>O<sub>2</sub>, H<sub>2</sub>O, NO</p> <p>CO<sub>2</sub></p> <p>CO</p> <p>unsaturated hydrocarbons</p>	<p>poison: strong chemisorptions or formation of compounds</p> <p>weak poison: oxidation of Fe surface; reduction possible but causes sintering</p> <p>inhibitor : reaction with alkaline promoters</p> <p>poison and inhibitor: strong chemisorption, reduction to methane; accelerates sintering</p> <p>inhibitor : strong chemisorption, slow reduction</p>
Hydrogenation	Ni, Pt, Pd, Cu	<p>S, Se, Te, P, As compounds, Halogens Hg and Pb Compounds</p> <p>O<sub>2</sub></p> <p>CO</p>	<p>poison: strong chemisorptions</p> <p>poison: alloy formation</p> <p>poison: surface oxide film</p> <p>Ni forms volatile carbonyls</p>

# Catalyst Deactivation

**Ronald Hughes**



## **Catalyst Deactivation:**

Catalyst Deactivation 1994 G.F. Froment, B. Delmon, 1994-09-08 Catalyst Deactivation 1994 was an expansion of earlier highly successful symposia. The objective of the symposium was to promote a scientific approach of the phenomenon of catalyst deactivation which will contribute to the development of catalysts which are less subject to structural transformations and more resistant to poisons and coke formation. These aspects are dealt with in 12 plenary lectures, 48 oral presentations and 35 poster papers which were critically selected from an impressive response from some 30 countries. Both fundamental and applied aspects were covered. The deactivation of catalysts in important industrial processes like fluid bed catalytic cracking, hydrotreatment, hydrodesulfurization, catalytic reforming, hydrodenitrogenation, steam reforming, hydrodemetallization, hydrocracking, Fischer-Tropsch synthesis, propane dehydrogenation, phthalic anhydride synthesis received considerable attention. Mechanisms of poisoning, sintering and coking were further investigated and modelled and new experimental techniques for the characterization and the quantification of deactivation were also introduced.

**Activation, Deactivation, and Poisoning of Catalysts** John Butt, 2012-12-02 Activation, Deactivation and Poisoning of Catalysts deals with the circumstances and mechanisms underlying catalyst activation, deactivation and poisoning. The emphasis is on the techniques for handling deactivating systems, not on results per se. Deactivation by fouling and sintering is given consideration. This book is organized into three sections and consists of 12 chapters. The first part is devoted to a systematic development of the manner in which catalysts are activated, deactivated, poisoned and in some cases reactivated on a microscopic basis. The first chapter explains the concept of the active center as utilized in catalysis along with catalyst regeneration, rejuvenation and detoxification. In the second part, the reader is introduced to the problem of heat transfer as well as the transport of reactants and products in the interior of the particle coupled with chemical reaction therein. The macroscopic deactivation behavior of the catalyst particle is described in terms of fundamental kinetic deactivation phenomena and of parameters governing heat and mass transfer. The last part is primarily concerned with a collection of catalyst particles within the reactor with emphasis on the global activity of the reactor. In the last chapter, a pragmatic approach is presented to predict the design and performance of chemical reactors containing a deactivating catalyst. This book is written for catalytic chemists, researchers, reactor designers and students interested in catalyst activation, deactivation and poisoning.

*Progress in Catalyst Deactivation* J.L. Figueiredo, 2012-12-06 Most catalysts used in the chemical and petrochemical industries are strongly affected by one or another form of deactivation leading to poor performances and reduced life. The increasing number of scientific communications devoted to the subject in recent years and culminating with an International Symposium held in Antwerp in October 1980 is a measure of the interest it arouses in both the industrial and academic communities. A stage has been reached whereby it was thought that a NATO Advanced Study Institute on Catalyst Deactivation might be fruitful in establishing the state of the art and in stimulating a more

systematic research on the phenomenon Such a meeting was held in Lagos Portugal from 18 to 29 May 1981 The purpose of the Institute was to present and discuss in a didactic and systematic way the various processes that lead to catalyst deactivation namely coking poisoning and solid state transformations and at the same time to promote the exchange of ideas and experiences among the participants drawn from industry and university The lectures presented at the Institute are collected in this volume with the exception of Dr L L Hegedus Catalyst Poisoning which has been previously published *Catalysis Reviews Science and Engineering* 23 377-476 1981 Catalyst Deactivation 1987 G.F. Froment, B.

Delmon, 1987-09-01 This Symposium on Catalyst Deactivation ensues those held at Berkeley 1985 Antwerp 1980 and Berkeley 1978 The three main topics emphasised at this most recent symposium were the techniques used in deactivation studies the mechanisms of catalyst deactivation and modelling With respect to the first it became apparent that the study of deactivation faces even more difficulties than the characterization of fresh catalysts and the measurement of activity or selectivity due to the multiplicity of interacting processes occurring during deactivation Quite substantial progress has been made recently in the understanding of the mechanisms of various deactivation processes particularly coking and extra time was accorded to these topics at the symposium The third topic corresponds to a problem which is very central to development studies and to the chemical engineering aspect of catalysis it deals with the representativity of accelerated tests and the modelling of the deactivation phenomena **Catalyst Deactivation 1980: International Symposium**

**Proceedings** B. Delmon, 2000-04-01 Catalyst Deactivation 1980 International Symposium Proceedings Catalyst Deactivation 1991 C.H. Bartholomew, J.B. Butt, 1991-06-03 Catalyst Deactivation 1991 was an expanded version of earlier highly successful symposia The symposium featured invited and solicited papers including 4 plenary lectures 78 oral presentations and 23 poster papers Most of the papers are contained in this volume The eight main topics emphasised at this most recent symposium were deactivation mechanisms phenomena carbon deposition poisoning and sintering methods modeling and techniques and important catalysts hydrotreating oxides and zeolites All of these areas were well represented as attested by the substantial number of papers contained in these proceedings Four review papers based on the plenary lectures provide state of the art perspectives on new thrusts in deactivation research and development *Deactivation and Poisoning of Catalysts* J. Oudar, 1985-07-02 Deactivation and Poisoning of Catalysts presents the most current research in the area of heterogeneous catalysis It focuses on the chemically induced effects associated with bonded surface species that cause catalyst activity decline and in some cases a change in catalyst specificity In addition this volume examines poisoning of dispersed metal catalysts the thermodynamics of sulfur metal and carbon metal interactions model poisoning reactions on single crystals deactivation in petroleum refining and petrochemical processes coking of metal catalysts and more The new approaches and solutions to catalyst deactivation and poisoning presented in this guide are invaluable to all heterogeneous catalysis specialists including chemical and petroleum engineers and surface synthetic physical and industrial chemists Book

jacket **Catalyst Deactivation 1997** G.A. Fuentes, C.H. Bartholomew, 1997-09-12 Catalyst Deactivation 1997 focused on 9 key topical areas carbon deposition and coke formation chemicals environmental catalysis modeling petroleum processing poisoning syngas conversion techniques and thermal degradation All of these areas were well represented at the meeting moreover several review articles were presented that provide perspectives on new research and development thrusts The proceedings of the meeting are organized with six review and award articles at the front of the volume followed by topical articles a keynote 5 6 oral and 2 3 poster papers A list of authors is provided at the end of the book It should be emphasized that all of the papers were ranked and reviewed by members of the Scientific Committee **Catalyst Deactivation 1997**

Calvin H. Bartholomew, Gustavo A. Fuentes, 1997-01-01 Hardbound Catalyst Deactivation 1997 focused on 9 key topical areas carbon deposition and coke formation chemicals environmental catalysis modeling petroleum processing poisoning syngas conversion techniques and thermal degradation All of these areas were well represented at the meeting moreover several review articles were presented that provide perspectives on new research and development thrusts The proceedings of the meeting are organized with six review and award articles at the front of the volume followed by topical articles a keynote 5 6 oral and 2 3 poster papers A list of authors is provided at the end of the book It should be emphasized that all of the papers were ranked and reviewed by members of the Scientific Committee **Deactivation of Catalysts** Ronald Hughes, 1984

**Catalyst Deactivation 1999** B. Delmon, G.F. Froment, 1999-09-22 Studies in catalyst deactivation play a major role in the identification of the real catalytic system in particular the structure and texture of the solid which is often in a metastable state as it is operated in the industrial reactor These studies also allow the identification of the experimental conditions which preserve this active and selective state This is crucial for a real understanding of catalysts and catalysis Another area of catalytic science concerns reactions kinetics which if properly determined are of paramount importance in the elucidation of mechanisms The behavior of the kinetics during aging and deactivation and an accurate modeling of the evolution of activity and selectivity are essential information for the process performance These are just two typical examples but quite generally the science of catalyst deactivation is going to be more oriented to fundamental issues **Catalysts for**

**Upgrading Heavy Petroleum Feeds** Edward Furimsky, 2007-09-12 The book provides the most up to date information on testing and development of hydroprocessing catalysts with the aim to improve performance of the conventional and modified catalysts as well as to develop novel catalytic formulations Besides diverse chemical composition special attention is devoted to pore size and pore volume distribution of the catalysts Properties of the catalysts are discussed in terms of their suitability for upgrading heavy feeds For this purpose atmospheric residue was chosen as the base for defining other heavy feeds which comprise vacuum gas oil deasphalted oil and vacuum residues in addition to topped heavy crude and bitumen Attention is paid to deactivation with the aim to extend catalyst life during the operation Into consideration is taken the loss of activity due to fouling metal deposition coke formed as the result of chemical reaction and poisoning by nitrogen bases Mathematical

models were reviewed focussing on those which can simulate performance of the commercial operations Configurations of hydroprocessing reactors were compared in terms of their capability to upgrade various heavy feeds providing that a suitable catalyst was selected Strategies for regeneration utilization and disposal of spent hydroprocessing catalysts were evaluated Potential of the non conventional hydroprocessing involving soluble dispersed catalysts and biocatalysts in comparison with conventional methods were assessed to identify issues which prevent commercial utilization of the former A separate chapter is devoted to catalytic dewaxing because the structure of dewaxing catalysts is rather different than that of hydroprocessing catalysts i e the objective of catalytic dewaxing is different than that of the conventional hydroprocessing The relevant information in the scientific literature is complemented with the Patent literature covering the development of catalysts and novel reactor configurations Separate chapter was added to distinguish upgrading capabilities of the residues catalytic cracking processes from those employing hydroprocessing Upper limits on the content of carbon residue and metals in the feeds which can still be upgraded by the former processes differ markedly from those in the feeds which can be upgraded by hydroprocessing It is necessary that the costs of modifications of catalytic cracking processes to accommodate heavier feeds are compared with that of hydroprocessing methods Objective of the short chapter on upgrading by carbon rejecting processes was to identify limits of contaminants in heavy feeds beyond which catalytic upgrading via hydroprocessing becomes uneconomical because of the costs of catalyst inventory and that of reactors and equipment Comprehensive and most recent information on hydroprocessing catalysts for upgrading heavy petroleum feeds Compares conventional modified and novel catalysts for upgrading a wide range of heavy petroleum feeds Comparison of conventional with non conventional hydroprocessing the latter involving soluble dispersed catalysts and biocatalysts Development and comparison of mathematical models to simulate performance of catalytic reactors including most problematic feeds Residues upgrading by catalytic cracking in comparison to hydroprocessing

Deactivation And Regeneration Of Zeolite Catalysts Michel Guisnet, Fernando Ramoa Ribeiro, 2011-02-21 In chemical processes the progressive deactivation of solid catalysts is a major economic concern and mastering their stability has become as essential as controlling their activity and selectivity For these reasons there is a strong motivation to understand the mechanisms leading to any loss in activity and or selectivity and to find out the efficient preventive measures and regenerative solutions that open the way towards cheaper and cleaner processes This book covers the fundamental and applied aspects of solid catalyst deactivation in a comprehensive way and encompasses the state of the art in the field of reactions catalyzed by zeolites This particular choice is justified by the widespread use of molecular sieves in refining petrochemicals and organic chemicals synthesis processes by the large variety in the nature of their active sites acid base acid base redox bifunctional and especially by their peculiar features in terms of crystallinity structural order and textural properties which make them ideal models for heterogeneous catalysis The aim of this book is to be a critical review in the field of zeolite deactivation and regeneration by collecting contributions from

experts in the field which describe the factors explain the techniques to study the causes and suggest methods to prevent or limit catalyst deactivation At the same time a selection of commercial processes and exemplar cases provides the reader with theoretical insights and practical hints on the deactivation mechanisms and draws attention to the key role played by the loss of activity on process design and industrial practice a **Zeolite Catalysts** Subhash Bhatia,2020-07-24 Presented in an easy to read form this book on zeolite catalysis cover all aspects of the subject It focuses on synthesis structure diffusion deactivation and industrial applications This book is an ideal text for courses on catalysis or as a supplementary text for those studying applied or industrial chemistry It is also a useful resource for anyone who works with zeolites as catalysts in the laboratory pilot plants or commercial installations *Basic Principles in Applied Catalysis* Manfred Baerns,2004-01-22 Applied catalysis is based nowadays not only on empirical knowledge but also on the many insights that have been gained from the fundamental understanding of catalysis It also comprises knowledge and expertise from catalytic reaction engineering in particular kinetics of the catalytic reaction and its interplay with heat and mass transfer as well as fluid dynamics and the specific conditions prevailing in the type of reactor used Applied catalysis comprises many areas from a reaction point of view many types of catalytic materials from which catalysts are formed are needed to achieve high selectivities and space time yields last but not least catalysts should have a long life time to which its deactivation is detrimental A catalytic material that fulfils all the demands then often requires special mechanical and thermal treatment to be used in practise Various books have been written about specific areas as mentioned above It is the intention of this contribution to present timely reports by well recognised experts in the field to outline the state of science and technology in selected but representative areas illustrating the basic principles of applied catalysis **Catalyst Deactivation 1987** Bernard Delmon,Gilbert F. Froment,1987 This Symposium on Catalyst Deactivation ensues those held at Berkeley 1985 Antwerp 1980 and Berkeley 1978 The three main topics emphasised at this most recent symposium were the techniques used in deactivation studies the mechanisms of catalyst deactivation and modelling With respect to the first it became apparent that the study of deactivation faces even more difficulties than the characterization of fresh catalysts and the measurement of activity or selectivity due to the multiplicity of interacting processes occurring during deactivation Quite substantial progress has been made recently in the understanding of the mechanisms of various deactivation processes particularly coking and extra time was accorded to these topics at the symposium The third topic corresponds to a problem which is very central to development studies and to the chemical engineering aspect of catalysis it deals with the representativity of accelerated tests and the modelling of the deactivation phenomena Source inconnue *Catalyst deactivation* Eugene E. Petersen,1987 Catalyst Deactivation 2001 J.J. Spivey,G.W. Roberts,B.H. Davis,2001-09-21 This proceedings contains the papers presented at the 9th International Symposium on Catalyst Deactivation held in Lexington KY USA on 7 10 October 2001 Catalyst Deactivation, 1991 Calvin H. Bartholomew,1991 Catalyst Deactivation 1991 was an expanded version of earlier

highly successful symposia The symposium featured invited and solicited papers including 4 plenary lectures 78 oral presentations and 23 poster papers Most of the papers are contained in this volume The eight main topics emphasised at this most recent symposium were deactivation mechanisms phenomena carbon deposition poisoning and sintering methods modeling and techniques and important catalysts hydrotreating oxides and zeolites All of these areas were well represented as attested by the substantial number of papers contained in these proceedings Four review papers based on the plenary lectures provide state of the art perspectives on new thrusts in deactivation research and development

*Factors Controlling the Activity and Selectivity of Hydrocarbon Reactions on Acidic Catalysts* George Yaluri, 1995

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